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(54) **Sheet-forming apparatus for a paper machine.**

(57) A sheet-forming apparatus for a paper machine having at least two fixed hydroextractors (9) which have separate locations for drainage to the hydroextractor side from locations for dispersion of fibres. These hydroextractors (9) are arranged alternately about two endless wire screen loops (1,2).

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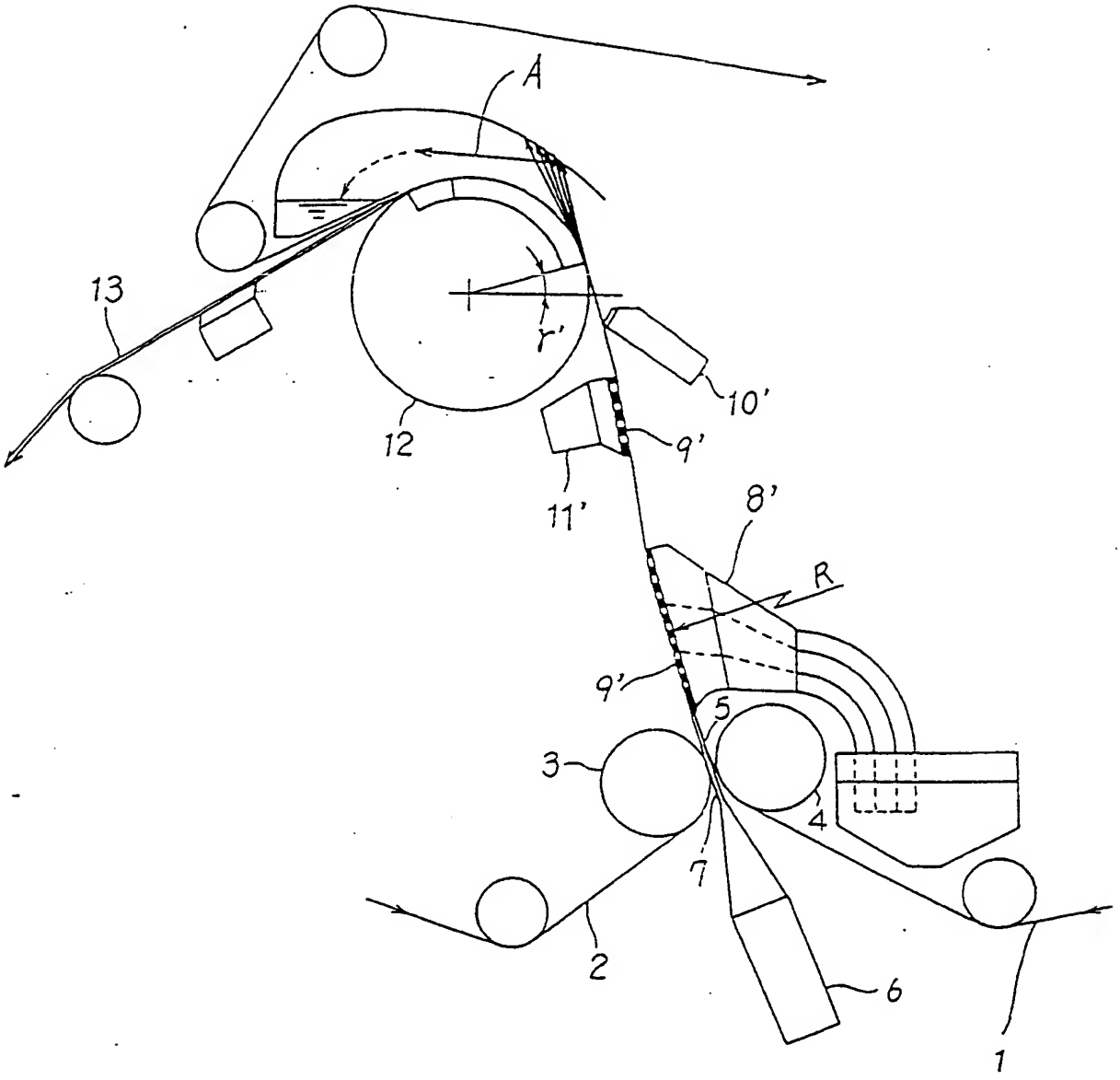
FIG. 1



The present invention relates to a sheet-forming apparatus for a paper machine.

In a twin wire former type of sheet-forming apparatus for a paper machine, two sheets made of woven wire form respective endless wire screen loops, between which the raw material liquid mixture (liquid plus fibres) is held and run; free water is removed from the raw material liquid mixture by various hydroextractors whereby a fibre mat grows gradually and a web is formed.

The above description is illustrated further in accompanying Figure 5 for the case of a sheet-forming apparatus having a fixed hydroextractor of a conventional shoe type. In this apparatus, two wire screens 1,2, guided by rolls 3,4, respectively, form a wedge shaped gap 5. Thereafter the wire screens come together so that they mutually overlap one another and pass over shoe blades 9 arranged on a prescribed curvature R as a part of a first fixed hydroextractor 8, running in a bent path along the curve of approximate radius R.

A jet of raw material mixture (liquid plus fibres) 7 is injected from a headbox 6 towards the gap 5 and is held between two wire screen sheets 1,2 so as to run at the same speed as the wire screens. Initial drainage starts when the raw material jet 7 is held between the two wire screens 1, 2 as a result of squeezing caused by the wire tension. However, most of the drainage is done subsequently on the shoe blades 9 by the pressure applied to the raw material mixture held between the wire sheets.

After leaving the shoe-blades 9, further draining of the raw material mixture occurs at a suction roll 12 forming a second hydroextractor and the resulting wet sheet 13 is transferred on the wire 2 to a subsequent press operation (not shown). In Fig. 5, the reference number 10 denotes a water deflector and the reference number 11 denotes a low vacuum box for draining by vacuum.

The structure and drainage effect of the known hydroextractors are now explained. Figs. 6 and 7 of the accompanying drawings show two examples of typical prior art arrangements of the shoe blades and model curves in respective examples illustrating the pressure applied to the raw material mixture disposed between the wire screens.

In Figs. 6 and 7, each shoe blade 9 is detachably mounted to the hydroextractor 8 by means of a guide on a supporter 14 fixed to the hydroextractor 8 and is arranged so that the surface on the centre line has a prescribed curvature R. Therefore, the number of blades and the pitch between them ar adjustable. The angles θ_1 and θ_2 at which th wire screens 1 and 2 b nd at the leading edge and at the trailing edge of the shoe, vary depending on th pitch (r fer to Fig. 7). The greater th pitch is, th greater become the angles; the p ak valu of the generated pressure b comes greater accordingly. By virtue of the resulting pressure, fibres in the raw material mixture held between the wire screens 1 and 2 are moved and dispersed further; simultaneously water is drained through both of the two wire screens.

Drainage is achieved in both directions with respect to the wire 1 side and the wire 2 side in the path extending between the shoe blades. On the other hand, drainage to only the wire 1 side occurs during passage over the shoe blade 9 because draining to the wire 2 side is inhibited by the shoe blade 9 itself, as illustrated by arrows in Figs. 6 and 7. Fibres in the raw material mixture can be divided into those which mat to form a sheet and those which are washed out with "white water" (mixture of drained water and some fibres).

It has been understood that the prior art fibre mat, formed by the pressure applied to the raw material mixture held between the two wire screens 1 and 2 during drainage in the region of the shoe blades 9, is the same both on the wire 1 side and in the wire 2 side. However, the actual effects of the shoe blade 9 on the mat formed on the wire 1 surface and on the wire 2 surface are not always the same. That is, the spacing between the two wire screen sheets 1 and 2 swells at the leading edge and at the trailing edge by respective applied pressure P_1 and P_2 as shown in Fig. 8. In this condition, fibres near the boundary of the wire screen 1 and the fibre mat 15' formed on the wire 1 side run with the wire while being fixed as the mat. On the other hand, the fibre mat 15" on the wire screen 2 side is subjected to a reaction force through the wire screen 2, when the wire screen 2 is scraped by the front edg of shoe blade 9. As a result of that force, fibres in the mat are moved further and dispersed, whereby short fibres lose connection with long fibres and tend to be washed out with water drained by the pressure P_1 to the mat 15", resulting in lower yield tendency of short fibres compared with the wire 1 side.

In a prior art sheet-forming apparatus, a fixed hydroextractor 8 of the above mentioned drainage characteristics is located only inside the wire screen 2 loop, as shown in Fig. 5. Thus, the top side tends to differ from the back side in the paper sheet formed by this apparatus. In order to mitigate these problems, papter industries are now managing by adopting different specifications for the wire screen 1 and for the wire screen 2. For example, the mesh of wire screen 2 is made to be finer than wire screen 1, that is, wire screen 2 has more weaves.

It is an object of the present invention to provide a sh et-forming apparatus for a paper machine which overcomes the problems of the prior art apparatus explain d above, improving the fibre yield and also reducing the difference betwe n topside and underside of the paper produc d.

For this purpose, the present invention provides an apparatus for forming paper sheet having at least two fix d hydroextractors which hav separate loca-

tions for drainage to the hydroextractor side and for dispersion of fibres; the hydroextractors are arranged alternately on opposite sides to two wire screen loops.

The front edge of the shoe blade is preferably formed so that the wire screens proceed without bending at that edge. Therefore, the front edge functions only for scraping white water as in the case of a foil blade of a fourdrinier paper machine. The pitch at which the shoe blades are installed is narrower than that of a fourdrinier paper machine. Thereby, deflection of the wire screens become far smaller and the degree of scraping becomes also smaller compared with prior art apparatus. Thus, compared to prior art machines, pressure generation between the shoe blades is small and the shearing force applied to the raw material mixture held between the wires is also small. Drainage by means of applied vacuum to the space between the blades improves the fibre yield since the drainage conditions are substantially the same as for the drainage of stable raw material mixture under vacuum.

By bending the wire screens at an intermediate position or at the back edge of the shoe blades, pressure in a pulse form necessary for further dispersion of the fibres in the raw material mixture is generated in the same manner as in a conventional apparatus; drainage to the shoe blade side at this location is restricted. Thus, the location where drainage to the hydroextractor is made and the location where fibres are dispersed are separated.

The fixed hydroextractors equipped with shoe blades are arranged alternately within the wire loop. Thereby, the effects of the shoe blades are directed alternately to the two sides of the mat being formed and thus, there develops no difference between the top side and the back side of the resulting paper. Initial set for the first fixed hydroextractor and for the second hydroextractor is made so that the two wire screens should not be bent at the back edge position of the last end of the first hydroextractor and at the front end position of the second fixed hydroextractor. However, the wire tends to bend during operation due to added thickness of the raw material. As countermeasures, the structure of the second fixed hydroextractor is made so as to move rotationally around a centre near its back end. Thereby, the wire screen can be supported without bending by adjusting the position of the front end in accordance with the thickness of the proceeding raw material.

The invention is described further h reinafter, by way of example only, with referenc to the accompanying drawings, in which:-

Fig. 1 is a side view of one example of a she t-forming apparatus embodying the present invention;

Fig. 2 is a d tailed lateral sectional view of a first embodiment of a hydro xtractor for an apparatus according to th pr sent invention;

Fig. 3 is a detailed lateral sectional view of a second embodiment of a hydroextractor for an apparatus according to the present invention;

Fig. 4 is a detailed lateral sectional view of the second fixed hydroextractor in the embodiment illustrated in Fig. 1;

Fig. 5 is a side view of sheet-forming apparatus having a known fixed hydroextractor of the shoe type;

Fig. 6 is a detailed lateral sectional view of a known fixed hydroextractor;

Fig. 7 is another detailed lateral sectional view of a known fixed hydroextractor; and

Fig. 8 is an enlarged side view of a shoe blade part of a known fixed hydroextractor.

Figure 1 shows one example of a sheet-forming apparatus in a paper machine having hydroextractors according to the present invention. Operating characteristics of the apparatus are shown in Fig. 2 and Fig. 3. Fig. 4 is a detailed drawing of the device indicating how the decision is made as to the location of the front edge of the second fixed hydroextractor. Constituent parts shown by the reference numbers 1 to 7 in Fig. 1 are identical with those used in Fig. 5 and function in essentially the same way. Thus, detailed explanations of these parts are omitted here. Reference number 8 "denotes a save-all" to recover drained white water.

In Fig. 2, the front (leading) edge 9'a of a shoe blade 9' is located so as to be in the same plane as the wire screen 2. Therefore, wire screens 1 and 2, between which raw material mixture is held, proceed to shoe blade front edge 9'a without any bending of wire screens 1 and 2 at this front end. Thus, only a small pressure (P_1') due to the collision reactive force of white water is generated, unlike the large pressure arising at the front edge of prior art shoe blade 9. The shearing force applied to mat between the wire screens is also small.

Vacuum is applied to the space between shoe blades 9'. Therefore, drainage in the region betwe n adjacent shoe blades 9' is nearly the same as static drainage.

Thus, the drainage V in this latter region is performed separately from the location of fibre dispersion, that is, in nearly the same manner as for static drainage, with a high yield.

Wire screens 1 and 2, holding the raw material mixture 15 that has passed the front edge 9'a of the sho blade, bend at the leading side of back edge 9'c with the angle of θ_2'. The shape of the back edg 9'c is made so that wire screens 1 and 2 must b nd in this way. With this arrangement, a pr ssure pulse is generated due to the same action as in the prior art shoe blade whereby furth r dispersion of fibres in the mat is promoted.

The peak pressure value is adjustable by providing a first land portion 9'b of inclined, generally con-

cave shape between the front edge 9'a and the back edge 9'c of the shoe blade 9' and by selecting the parameters (1,α) governing the wedge-shaped space formed by the inclined bottom surface and th wire screen 1. This is apparent from a prior art disclosure (Japanese Patent Provisional Publication No. 133689/1990 (2-133689)).

The part near back edge 9'c of the shoe blade in said wedge-shaped space, which is associated with a positive pressure P_2' on the raw material mixture between the wire sheets, is filled with the white water which has drained, as taught in said prior art disclosure. Thus, dropping out of short fibres, which often occurs at prior art shoe blades, is avoided and the yield at the shoe blade side is improved.

Fig. 3 shows another example of a shoe blade attaining the object of the present invention. The functions of parts 9"a to 9"c in Fig. 3 are the same as those of 9'a to 9'c in Fig. 2. Shoe blade 9" has a second land part 9"d declining towards the downstream side, in a similar manner to a file blade of a Fourdrinier paper machine. Vacuum force generated in the space formed by the second land part 9"d and wire screen 1 removes water, saving the vacuum force. The drainage capacity is adjustable by changing angle β as is the case of a Fourdrinier paper machine.

The raw material mixture held between the wire screens 1 and 2 passing through the first hydroextractor 8' towards the downstream side, reaches the front edge of No. 1 shoe blade 9'a mounted on the second fixed hydroextractor 11'. The second fixed hydroextractor 11' is supported, as shown in Fig. 4, by a rotatable support device 16 whose supporting point 11'a is located near the back end and is set so that the wire screen 2 proceeds without bending at the front edge position of No. 1 (the front end) shoe blade 9'a by making the wire 2 lie at a distance from the shoe-blade corresponding to the thickness of raw material. The rotatable position is adjusted by detecting the white water taken out at said front edge. Thus, white water is taken out at the front end without scraping the formed mat on the wire screen 2 side. Further, on the second fixed hydroextractor 11', the wire screen 2 side (that was outside at the first fixed hydroextractor 8' part) of raw material liquid held between wire screens 1 and 2 is subjected to a draining action as explained above while running on the surface of shoe blade 9'.

Thus, the mat running after the second hydroextractor 11' has the same history at both sides and the difference b tw en the top side and the back side is smaller, resulting in the achievement of a good yield of fine fibres. The mat is despatched to the suction roll 12 under such conditions. The function of th downstream equipment is the sam as that of the prior art. It will be clear that th drainag at both sides of high yield rolls does not impair the characteristics of the formed mat. However, by consideration of th treatment of white water (shown by arrow mark A in Fig. 1) drained towards the outside of the roll, a more inclined wire run (in the direction of the wire screen movement) at the contact point of wire 2 on suction roll 12 makes the treatment easier. (For reference, γ' [Fig.1] > γ [Fig.5]).

By use of the present invention, the yield is improved by separating the drainage locations to the machine side from the locations for fibre dispersion during drainage by the fixed hydroextractors. Furthermore, drainage zones for both sides of paper are separated and respective drainage control is possible. Moreover, by arranging the hydroextractors alternately in the two endless wire screen loops, difference between the top side and the back side of the paper is improved and the operational life of both wire screens become nearly the same because both wire screens run along similar fixed hydroextractors. Therefore, the life of both wire screens becomes nearly the same and the shut down period of the machine is shortened.

Claims

1. An apparatus for forming paper sheet from a raw material mixture, comprising a pair of wire screen loops between which the mixture is carried for forming a fibre mat, and a fixed hydroextractor for extracting liquid from the mixture, characterized in that:
   (a) a location where drainage to the hydroextractor is made is arranged to be separated from a location where fibres in the mixture are dispersed;
   (b) there are at least two hydroextractors; and
   (c) said hydroextractors are arranged alternately on the two sides of the two wire loops.

2. A sheet-forming apparatus according to claim 1, wherein said separation is achieved in that:
   (a) the wire screens (1,2) proceed without bending at a front edge of a shoe blade (9', 9"); and
   (b) the wire screens (1,2) are arranged to bend at an intermediate or a rear edge of the shoe blade (9', 9").

3. A sheet-forming apparatus according to claim 1 or 2, wherein a wedge-shaped space is formed by:
   (a) a first land part (9'b) formed by inclining the surface of the shoe blade (9') between the front edg (9'a) and the back edge (9'c) of the sho blade (9'); and
   (b) th wire scr ns (1,2).

4. A sh et-forming apparatus according to claim 3, wherein th shoe blade (9") is provided with a

s cond land part (9"d) declining towards the downstream edge of the blade (9").

5. An apparatus for forming paper sheet having a fixed hydroextractor, characterized by:
   (a) separating a place where drainage to the hydroextractor side is made from a place where fibres are dispersed; and
   (b) a first hydroextractor (8') and a second hydroextractor (11') are arranged alternately in two wire screen loops (1,2).

6. A sheet-forming apparatus of paper machine according to claim 5, wherein said separation is made by:
   (a) arranging for the wires (1,2) to proceed without bending at a front edge of a shoe blade (9', 9"); and
   (b) arranging for the wires to bend at an intermediate position or at a back edge of the shoe blade (9', 9").

7. A sheet-forming apparatus according to claim 5 or 6, wherein a wedge-type space is formed by:
   (a) a first land part (9"b) formed by inclining the surface of the shoe blade between the front edge and the back edge of the shoe blade; and
   (b) the wire screens (1,2).

8. A sheet-forming apparatus according to claim 7, further characterised by that the shoe blade is provided with a second land part (9"d) declining toward the downstream direction.

9. A sheet-forming apparatus according to claims 5 to 8, wherein the second fixed hydroextractor (11') causes the wire screen (2) to proceed without bending at the front edge position of the first, front end shoe blade (9') of the second fixed hydroextractor (11') by means of a rotatable support device (16) which is pivotally supported adjacent its rear end.

FIG. 1

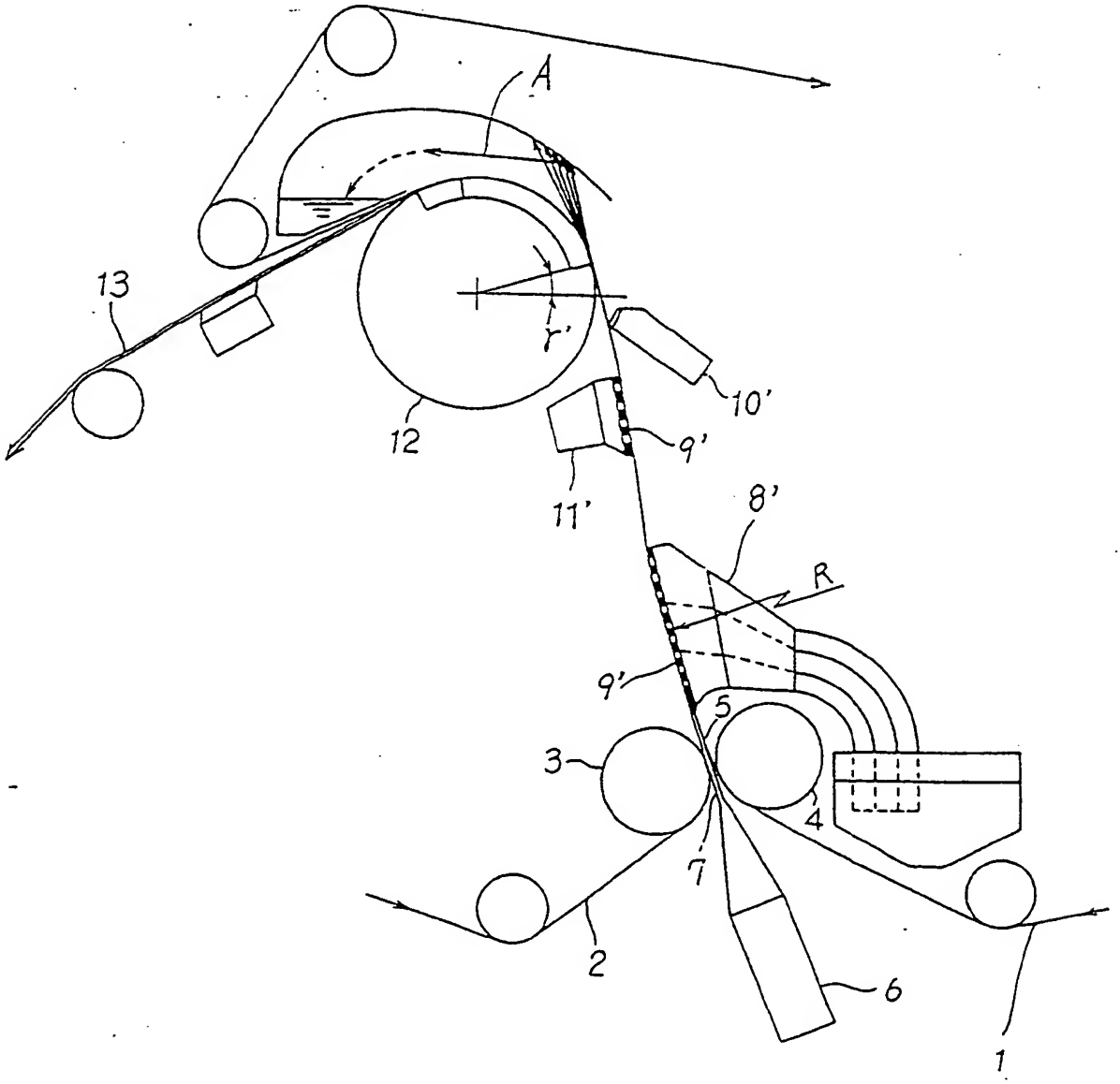


FIG. 2

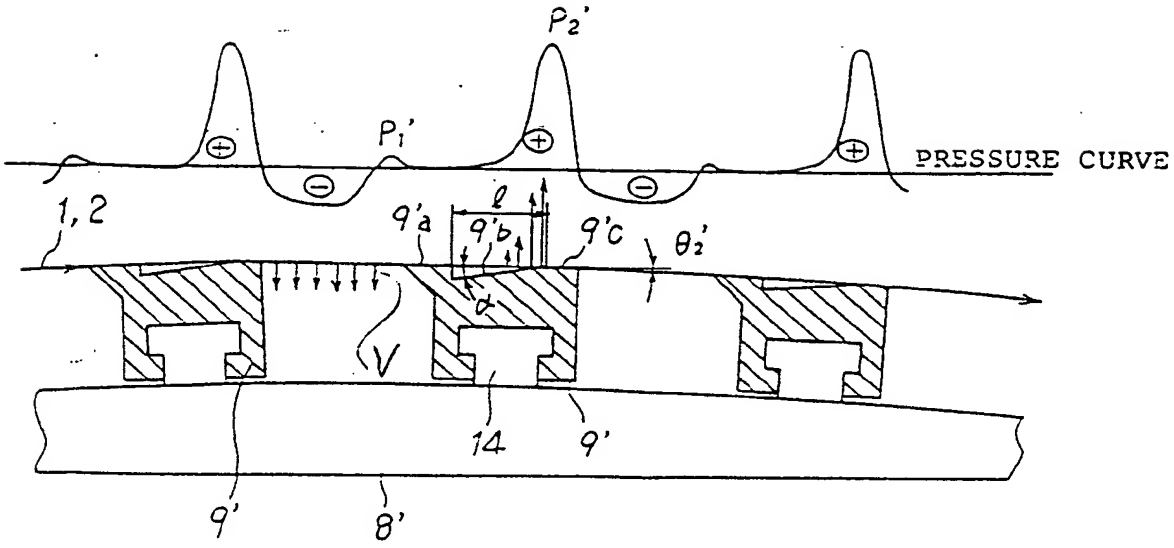

P2'
P1'
PRESSURE CURVE
1, 2
9'a
ℓ
9'b
9'c
θ2'
α
V
14
9'
9'
8'

FIG. 3

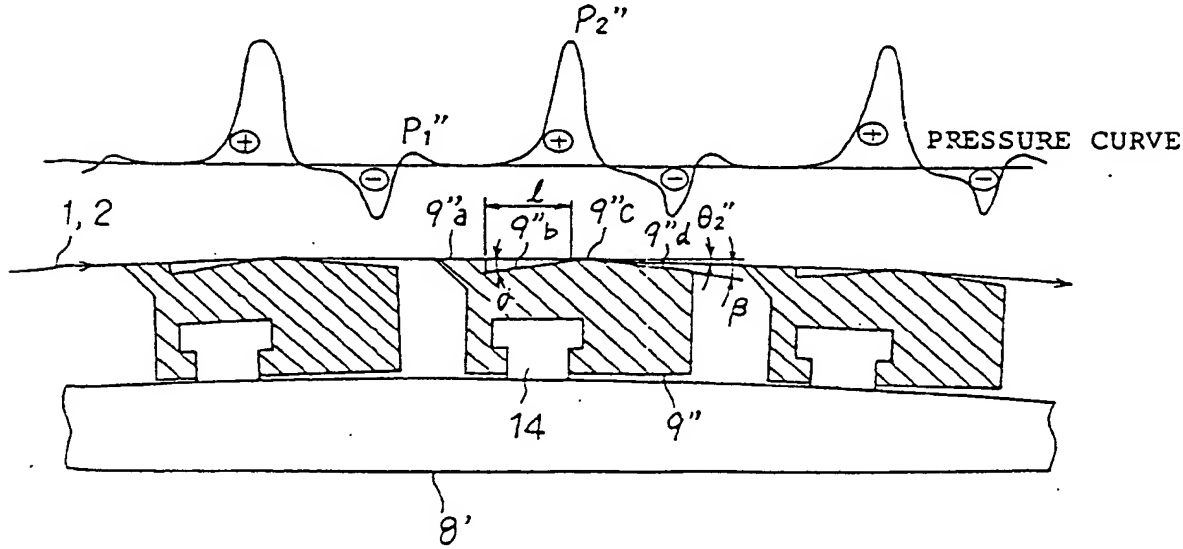

P2"
P1"
PRESSURE CURVE
1, 2
9"a
ℓ
9"b
9"c
9"d
θ2"
α
β
14
9"
8'

FIG. 4

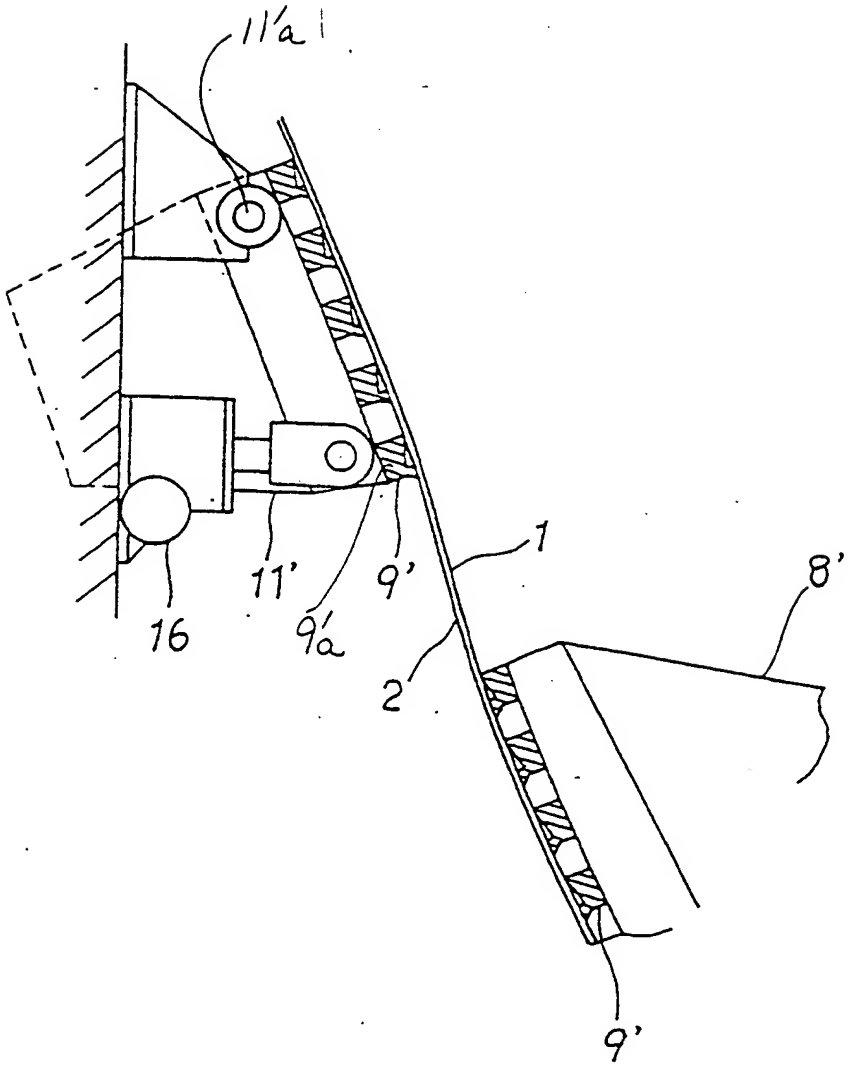


FIG. 5 (PRIOR ART)

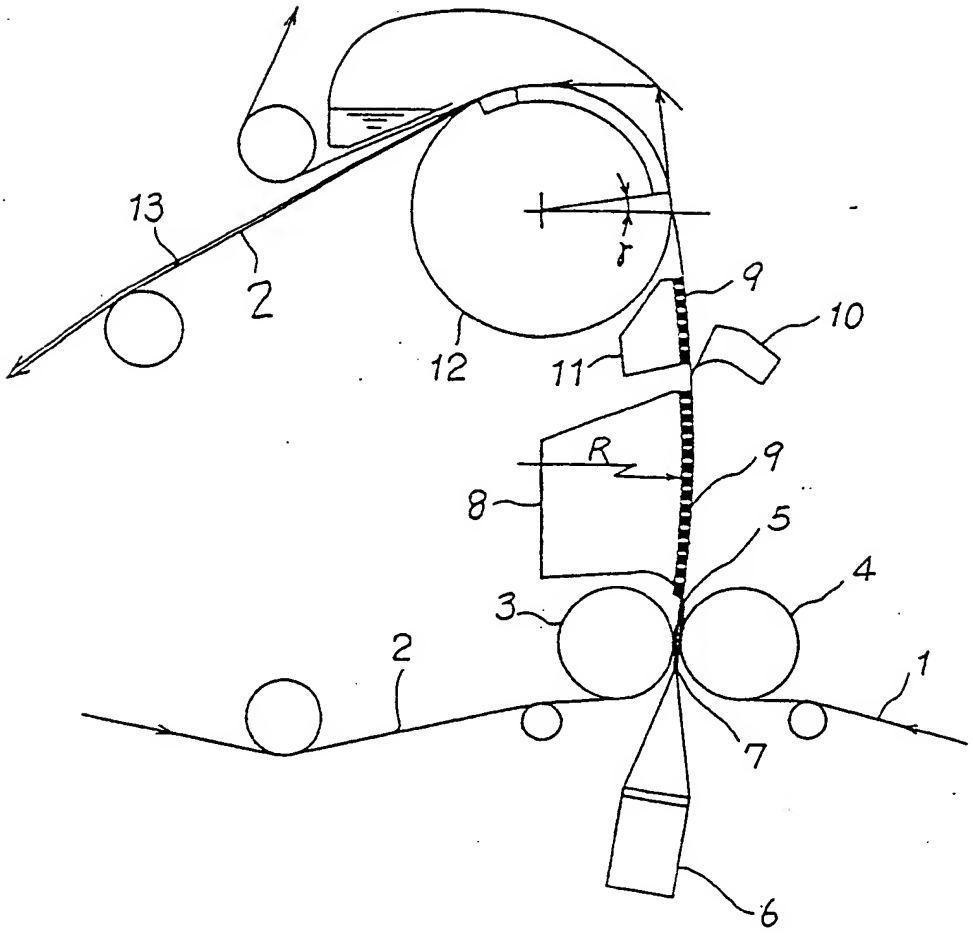


FIG. 6 (PRIOR ART)

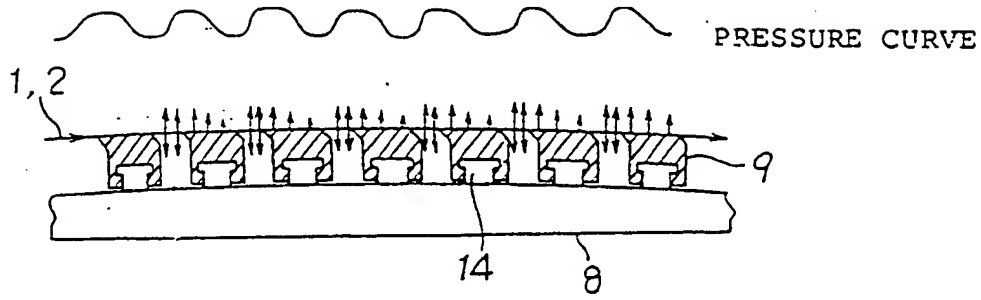


FIG. 7 (PRIOR ART)

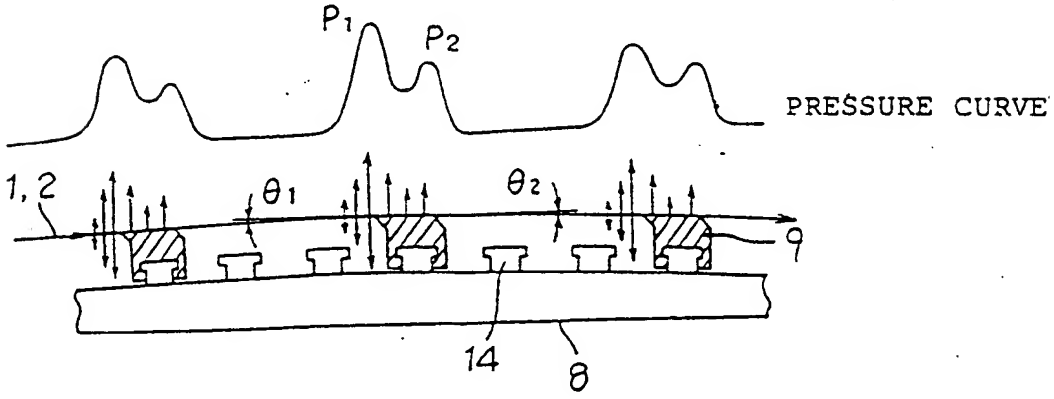
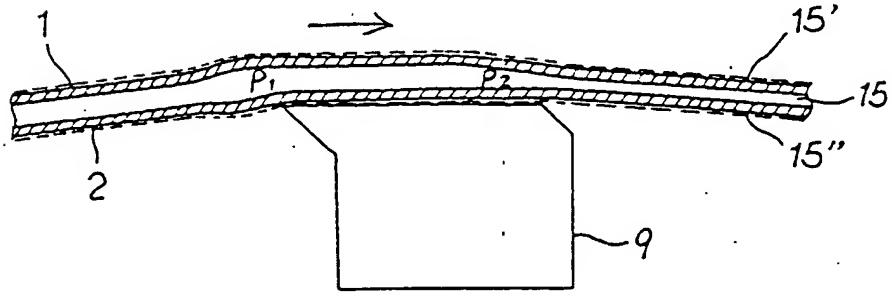


FIG. 8 (PRIOR ART)



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EUROPEAN SEARCH REPORT

Application Number

EP 91 30 6945

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-4 790 909 (HARWOOD) * column 3, line 64 - column 5, line 9; claim 1; figure 1 *	1,5	D21F9/00
Y		2-4,6-9	
X	US-A-3 944 464 (MEANS) * the whole document *	1,5	
Y		2-4,6-9	
Y	WO-A-8 606 117 (FELDMÜHLE AG) * the whole document *	2-4,6-8	
Y	GB-A-1 382 791 (PULMAC RESEARCH) * the whole document *	2,3,6,7	
Y	DE-A-3 315 023 (VALMET OY) * the whole document *	9	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			D21F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 NOVEMBER 1991	DE RIJCK F.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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& : member of the same patent family, corresponding document

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